UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAUS OF HOME ECONOMICS AND ANIMAL INDUSTRY
WASHINGTON, D.C.

REPORT TO THE 1934 CONFERENCE ON COOPERATIVE MEAT AND LARD INVESTIGATIONS.

Studies on Lard and Competing Fats. I. Flavor.

The Bureaus of Animal Industry and Home Economics have studied cooperatively the intensity and desirability of aroma and flavor of six fats when used as the shortening in hot biscuits.

The fats under investigation were composite samples each of three prime steam lards, three dry rendered lards and three kettle rendered lards, also a hydrogenated lard, a hydrogenated cottonseed oil and an oleo-stearin cottonseed oil compound.

The fats were stored at 30°F. during the ten weeks period of the experiment. At the beginning of each week sufficient fat was removed from the stored fats to make sufficient biscuits for three days. These fats were kept in tightly closed containers in the refrigerator at 40° to 45°F. during the week they were used. A slightly rich biscuit formula containing all the normal ingredients except salt was used, as follows:

80	grams fat
261	" flour
8.75	" baking powder
140-150	cc. water

Each fat was incorporated in the formula; mixed, and baked in a uniform manner. An absolute judgment was made on each biscuit when hot (internal temperatures 94° ± 1°C.) by three judges. During the series of 30, 12 individuals recorded judgments on the intensity and desirability of aroma and flavor of the biscuits.

A statistical analysis of the judgments shows that the fats with the least intensity of aroma and flavor were considered the more desirable in

aroma and flavor. The fats having the less intense flavor and aroma and which were significantly more desirable in these respects were kettle rendered lard, hydrogenated lard and hydrogenated cottonseed oil.

Chemical and physical analyses were made on these fats at the beginning and at the close of the experiment. The results of the analyses show no significant differences in free fatty acids with only slight increases in peroxide values. There was no detectable odor of rancidity. The fats apparently deteriorated very slightly during the course of the experiment.

At the request of the Institute of American Meat Packers biscuits from the same set judged by the Washington judges were sent by air mail to Chicago. The biscuits were judged there, after reheating, within 2 to 6 days after baking. By far the greatest part of the judging was done on the 3rd day after baking, after staling had set in. Due to the shortage of fats, it was impossible to make sufficient biscuits for the Washington group to judge biscuits under the same conditions, so no comparison of results can be made.

Studies on Lard and Competing Fats. II. Deep fat frying.

The Bureaus of Home Economics, Animal Industry and Plant Industry have studied cooperatively the use of nine fats as a frying medium for potato chips. The fats studied included three kettle rendered lards produced by the Bureau of Animal Industry at Beltsville, Maryland from animals fed a peanut, corn, and brewer's rice ration respectively, and a representative sample each of prime steam lard, hydrogenated lard, hydrogenated cottonseed oil, and highly refined corn oil, cottonseed oil and peanut oil. The commercial samples of fats were obtained directly from the manufacturers at the time the experimental lards were rendered at Beltsville. All the fats were stored in 8-pound containers at a temperature of 4.4° to 7.2°C. during the period of the experiment.

The potatoes used were the Green Mountain variety harvested from the Bureau of Plant Industry plot at Presque Isle, Maine, by October 1. The potatoes were held in storage at a temperature of 15°C. during the period of the experiment.

The potatoes were prepared for chips by a uniform method throughout. The initial amount of fat used for frying was 2 kilograms. During the frying life of each fat approximately 3.2 kilograms of potato slices were fried in each of the fats. This amount was fried in ten heatings of each fat, using 400 grams in 100 gram lots in the initial frying. As the quantity of each fat diminished a corresponding decrease was made in the quantity of potato slices fried at one time so that the weight ratio of fat to slices was always the same. The total heating time for the 2 kilograms of fat in the series was $8\frac{1}{2}$ hours during which the potato slices were actually frying for 80 minutes. The average frying temperatures of each fat were: initial temperature 185°C., $\frac{1}{2}$ minute 161°C., 1 minute 152°C., $1\frac{1}{2}$ minutes 149°C., 2 minutes 148°C. The frying series just described was made in duplicate.

The potato chips were judged independently for intensity and desirability of flavor, aroma, color, luster, oiliness, crispness, and general desirability by three judges the day following the fryings. The fat absorbed by the chips fried in the various fats was determined quantitatively during the frying life of the fat. A comparison was made of the stability of samples of the chips fried in the different fats under varying conditions of storage, including temperature and type of package. The progressive deterioration of each fat used for frying was determined by chemical and physical means.

Results

Fats

The chemical and physical determinations on the fats, including peroxide values, Kreis test, free fatty acids and smoking point before use showed values typical of fats in a good state of preservation.

Upon comparing the analyses of the fresh fats with those of the fats at the end of the tenth frying of potato chips, it was found that the iodine numbers of all the fats decreased. This decrease was rather uniform, ranging from 3 to 5 iodine number units.

The peroxide values of the fats after the tenth frying approached those of fats showing incipient organoleptic rancidity. Organoleptic tests showed corn lard to be the most strongly rancid of the lards, while the hydrogenated lard was the more rancid of the hydrogenated products. The hydrogenated lard in addition to having a rancid odor had a peculiar odor not detectable in the other fats. The vegetable oils, if rancid, were only slightly so.

About 0.2% free acid above that initially present calculated as oleic acid was developed in each of the lards, while in the hydrogenated cottonseed oil and the vegetable oils only about 0.1%.

A comparison of the fats extracted from chips from the first frying and from the tenth frying showed values for free fatty acid and peroxide in many cases twice as high in the tenth frying as in the first, indicating that the fat after nine fryings was no longer suitable for this purpose. This was borne out by the appearance of the fats and the poor quality of the potato chips fried in them. There was no significant difference in the rate of deterioration of the fats from the first to the tenth frying as shown by the judgments on the chips from each successive frying.

Potato Chips

Of the palatability factors judged in the chips there was a significant difference only in the intensity of luster and the desirability of flavor. There was also a significant difference in the general desirability of the chips fried in the various fats. The judgments on the chips in the two series were on the whole corroborative.

Luster, cottonseed oil, peanut oil, peanut lard and corn oil formed one group giving a high lustre to the chips, while hydrogenated lard, corn lard, and rice lard formed a lower group that gave a significantly duller luster than the upper group. Hydrogenated cottonseed oil and prime steam lard occupied a position between these two groups.

Desirability of flavor, Peanut oil and corn oil gave the most desirable flavor to the potato chips but were not significantly different from each other. Peanut oil, corn oil, cottonseed oil and hydrogenated cottonseed oil gave a significantly more desirable flavor to potato chips than the lards.

General Desirability. Each judge gave an opinion in terms of very poor, poor, fair, good and very good concerning the chips fried in each fat. Peanut oil gave the best general results in frying potato chips. The difference between it and corn oil was not very important in one series and not significant in the other. The data indicated that corn oil, cottonseed oil and hydrogenated cottonseed oil were not significantly different in desirability as a medium for frying potato chips. Peanut lard and hydrogenated lard were next in desirability and corn lard, rice lard, and prime steam lard were equivalent but less desirable for this use.

Absorption of fat. The values for the percentages of fat absorbed by the chips fried in the various fats were not significantly different. An average of 42.8 percent of fat was absorbed by the chips.

Storage of chips. Samples of chips from the first frying were stored in white and in Coe-green bags at room temperature and in a refrigerator. The free acidity developed in the fat of the chips stored at room temperature was slightly higher in the case of the chips stored in green bags. The same was true of the peroxide value, although in the case of the oils and hydrogenated

cottonseed oil it was not so great. An explanation for this might be found in the recent work of Coe* in which he pointed out that it is possible for a fat protected with sextant green paper to develop a high peroxide value and yet not be organoleptically rancid, because the green inhibits the breaking down of the peroxides. This was borne out somewhat by the organoleptic tests. The chips in the green bags in the case of the hydrogenated lard and cottonseed oil did not develop rancid odor and taste until 39 to 46 days respectively, while the chips in the white bags for those two fats became rancid in 32 and 26 days respectively. As would be expected, the refrigerator stored chips, in general, took a greater number of days to become rancid.

*J. Ind. and Eng. Chem. 26, (3) 245 (1934).

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